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An ASSESSMENT OF POTENTIAL HYDROLOGIC AND ECOLOGIC IMPACTS OF CONSTRUCTING MITIGATION WETLANDS, RIFLE, COLORADO, UMTRA PROJECT SITES

April 1995

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**AN ASSESSMENT OF POTENTIAL HYDROLOGIC AND ECOLOGIC
IMPACTS OF CONSTRUCTING MITIGATION WETLANDS
RIFLE, COLORADO, UMTRA PROJECT SITES**

April 1995

**Prepared for
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LIST OF ACRONYMS

<u>Acronym</u>	<u>Definition</u>
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FWQC	Federal Water Quality Criterion
FWS	U.S. Fish and Wildlife Service
MCL	maximum concentration limit
ppm	parts per million
UMTRA	Uranium Mill Tailings Remedial Action
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

This assessment examines the consequences and risks that could result from the proposed construction of mitigation wetlands at the New and Old Rifle Uranium Mill Tailings Remedial Action (UMTRA) Project sites near Rifle, Colorado. Remediation of surface contamination at those sites is now under way. Preexisting wetlands at or near the Old and New Rifle sites have been cleaned up, resulting in the loss of 0.7 and 10.5 wetland acres (ac) (0.28 and 4.2 hectares [ha]) respectively. Another 9.9 ac (4.0 ha) of wetlands are in the area of windblown contamination west of the New Rifle site.

The U.S. Army Corps of Engineers (USACE) has jurisdiction over the remediated wetlands. Before remedial action began, and before any wetlands were eliminated, the USACE issued a Section 404 Permit that included a mitigation plan for the wetlands to be lost. The mitigation plan calls for 34.2 ac (13.8 ha) of wetlands to be constructed at the south end and to the west of the New Rifle site.

The mitigation wetlands would be constructed over and in the contaminated alluvial aquifer at the New Rifle site. As a result of the hydrologic characteristics of this aquifer, contaminated ground water would be expected to enter the environment through the proposed wetlands. A preliminary assessment was therefore required to assess any potential ecological risks associated with constructing the mitigation wetlands at the proposed location.

1.1 STUDY LIMITATIONS

A complete understanding of the river/alluvial aquifer system and present contaminant distribution at the New Rifle site is limited by the following factors.

- The annual extent and magnitude of the Colorado River's influence on natural flushing or dilution of contaminants has not been determined. Data collection began in the fall of 1994 to gain further understanding of river/alluvial aquifer system hydrodynamics.
- Historical ground water quality data, including ground water data from the area of two settling ponds used during uranium processing, is lacking for the eastern portion of the planned mitigation wetland (Figure 1.1). Because this portion of the wetland is crossgradient or upgradient from the former tailings pile, it is assumed that alluvial water quality has not been as seriously impacted as in the western portion.
- Aquifer testing of the alluvium at the New Rifle site has been very limited. Therefore, the variability of hydraulic conductivity in the area of the planned wetlands is uncertain.

As a result of the above limitations, only general statements can be made about how contaminants within the system will respond to fluctuating river stage and ground water level. However, since historical water quality data exists from downgradient portions of the proposed mitigation wetland, reasonable predictions can be made concerning the potential for contaminants to migrate into the wetlands.

2.0 STUDY SITE

The proposed mitigation wetland will consist of three plant community types (Figure 1.1):

- 12.3 ac (4.9 ha) of emergent plants consisting of cattail and bulrush.
- 16.4 ac (6.6 ha) of wet meadow planted with various grass species.
- 5.5 ac (2.2 ha) of shrub wetlands planted with willow and a grass ground cover.

The east end of the proposed wetlands will be very near the Colorado River; the western section will be about 750 feet (ft) (250 meters [m]) north of the river. The wetlands will be created by excavating 3 to 4 ft (1 m) down to the average-precipitation-year water table. The wet meadow and shrub wetlands will generally be just above the water table, and the cattail wetland will be down to 1 ft (0.30 m) below this elevation during the spring and summer.

Figures 2.1 and 2.2, ground water contour maps from April and September 1989, show that the western half of the cattail wetlands is downgradient from the Rifle tailings area, and the eastern half is crossgradient or upgradient. If constructed at the proposed location, the majority of the mitigation wetlands wet meadow/shrub wetland area will be constructed directly downgradient from the New Rifle site.

Wildlife use

The determination of which wildlife species are likely to occur at the mitigation wetlands is based on limited field reconnaissance surveys and a review of the pertinent literature. The species mentioned here do not represent a complete list of wildlife that could occur at or near this wetland; rather, this report lists the more common species expected at the site.

Amphibians and reptiles that may occur include the Woodhouse toad, northern leopard frog, racer, corn snake, bullsnake, and western terrestrial garter snake (Hammerson, 1986).

Fifty-one species of breeding birds may occur at or near the mitigation wetlands (Table 2.1). The breeding bird composition of the mitigation wetlands is likely to include many of these species. Breeding bird studies in marsh habitat have shown that density is quite high and can range from 250 to 400 or more breeding pairs per hundred acres (Van Velzen, 1980). Based on these numbers, the projected density of breeding birds at the 34-ac (14-ha) mitigation wetlands is 85 to 136 pairs.

The mitigation wetlands are likely to attract aquatic mammals such as muskrat, a species known to inhabit a wetland about 1500 ft (460 m) north of the location proposed for the mitigation wetlands. However, the mitigation site is not expected to provide year-round habitat for the muskrat because standing water will be present only during the spring and summer. Small mammals such as voles and mice and larger mammals such as rabbits, hares, raccoons, and mule deer are expected to use the mitigation site to varying degrees.

NOTE: WELLS 1 THROUGH 7
ARE MARK WEL POINTS.

Diagram illustrating the well and surrounding ground water conditions:

- WATER TABLE ELEVATION IN FEET ABOVE MSL: 6262
- GROUND WATER ELEVATION IN FEET ABOVE MSL: 6261.63
- WELL MONITOR
- GROUND WATER FLOW DIRECTION: Indicated by an arrow pointing right.
- ELEVATION CONTOUR
- DIPT ROAD

PROPOSED CATTAL		DESIGNATED SITE BOUNDARY
PROPOSED WET MEADOW SHRUB		EPHEMERAL STREAM
GRAVEL PIT		INTERSTATE
WETLAND		U.S. HIGHWAY

LEGEND

DESIGNATED SITE BOUNDARY
PERMANENT STREAM
INTERSTATE
U.S. HIGHWAY

FIGURE 2.2
WATER TABLE CONTOUR MAP OF THE
ALLUVIAL AQUIFER IN THE VICINITY OF THE
NEW RIFLE, COLORADO, PROCESSING SITE, SEPTEMBER 1989

**Table 2.1 Bird species that could potentially nest at the
Rifle UMTRA Project mitigation wetlands**

	Habitat	Breeding season	Diet
Pied-Billed Grebe	M,L	April - May	Fish, aquatic invertebrates
Great Blue Heron	R,S,L	March - May	Fish, aquatic invertebrates, small vertebrates
Black-Crowned Night Heron	M,L,S	April - July	Fish, aquatic invertebrates
Canada Goose	M,L,S	March - ?	Aquatic vegetation, grass, invertebrates
Mallard	M,L,S	March - July	Aquatic vegetation, aquatic invertebrates, grain
Gadwall	M,L,S	April - July	Aquatic vegetation, aquatic invertebrates
Pintail	M,L,S	May - July	Aquatic vegetation
Green-Winged Teal	M,L,S	May - August	Aquatic invertebrates, seeds, aquatic vegetation
Blue-Winged Teal	M,L,S	May - July	Aquatic vegetation
Cinnamon Teal	M,L,S	May - June	Aquatic vegetation
American Widgeon	M,L,S	May - June	Aquatic invertebrates, aquatic vegetation
Common Merganser	M,L,S,R	May - June	Fish, aquatic invertebrates
Northern Harrier	M	March - July	Small vertebrates, insects
American Kestrel	M,L,S	April - June	Small vertebrates, insects
Virginia Rail	M	May - July	Aquatic invertebrates, seeds
Sora	M	April - July	Insects, aquatic invertebrates
American Coot	M,L	April - July	Aquatic vegetation, aquatic invertebrates, insects
Killdeer	M,L,S	April - July	Insects
Common Snipe	R	April - July	Insects, small invertebrates
Spotted Sandpiper	L,S	May - July	Aquatic invertebrates
Common Nighthawk	R	April - July	Insects

**Table 2.1 Bird species that could potentially nest at the
Rifle UMTRA Project mitigation wetlands (Continued)**

	Habitat	Breeding season	Diet
Belted Kingfisher	R	April - July	Fish, small invertebrates
Western Kingbird	R	April - July	Insects, berries
Say's Phoebe	R	March - July	Insects, berries
Willow Flycatcher	R	May - July	Insects, berries
Olive-Sided Flycatcher	R	May - July	Insects
Barn Swallow	R,M,L,S	April - July	Insects
Cliff Swallow	R,M,L,S	April - August	Insects
Black-Billed Magpie	R	March - June	Omnivorous
Common Crow	R	February - June	Omnivorous
Dipper	S	March - June	Aquatic invertebrates, fish
Bewick's Wren	R	March - June	Insects
Northern Mockingbird	R	March - August	Insects, fruit
Gray Catbird	R	May - August	Insects, fruit
American Robin	R	April - July	Insects, fruit
European Starling	R	April - July	Insects, fruit, seeds
Yellow Warbler	R	April - July	Insects
Common Yellowthroat	M	April - July	Insects
Yellow-Breasted Chat	M,R	April - August	Insects, berries
Green-Tailed Towhee	R	May - April	Insects, seeds, berries
Rufous-Sided Towhee	R	April - August	Insects, seeds, fruit
Savannah Sparrow	M	March - July	Insects, seeds, snails
Chipping Sparrow	R	March - August	Insects, seeds
Song Sparrow	M	Feb. - August	Insects, seeds
Yellow-Headed Blackbird	M	April - June	Insects, fruits
Red-Winged Blackbird	M	March - July	Insects, seeds
Northern Oriole	R	May - June	Insects, fruit, nectar

**Table 2.1 Bird species that could potentially nest at the
Rifle UMTRA Project mitigation wetlands (Concluded)**

	Habitat	Breeding season	Diet
Brewer's Blackbird	R	March - July	Insects, seeds, fruits
Black-Headed Grosbeak	R	April - July	Insects, seeds, fruits
American Goldfinch	R	June - Sept.	Seeds, insects
Lesser Goldfinch	R	April - August	Seeds, insects

M = marsh, R = riparian, S = stream/river, L = lake/pond.

3.0 HYDROLOGIC CONCERNS

The planned construction of the mitigation wetlands (Figure 1.1) downgradient from the New Rifle site has raised the following hydrologic concerns. First, because most of the proposed wetlands will be hydraulically downgradient or crossgradient from the New Rifle site, contaminated ground water would be expected to enter the wetlands when the ground water table is near or above the ground surface. If the exposed ground water is not flushed and becomes stagnant, contaminants could build up in the wetlands. A second concern is that evapotranspiration could alter natural hydraulic gradients in the area, which could negatively influence the potential ground water remediation strategy of natural flushing.

3.1 POTENTIAL FOR CONTAMINANT ACCUMULATION IN THE WETLAND

Figures 3.1 and 3.2 are uranium and selenium isopleth maps of March 1994 water quality data from the alluvial aquifer at the New Rifle site. The uranium isopleth roughly approximates the limit of the most contaminated area at the New Rifle site and vicinity. The selenium isopleth is included because selenium is potentially the most ecologically toxic of all contaminants of concern. Although data used in the isopleths are limited by the small number of monitor well locations and the area over which selenium is discharging to the proposed wetlands appears limited to the western portion of the cattails, the isopleths do demonstrate that ground water in the planned area of the mitigation wetlands is contaminated with tailings leachate above both maximum concentrations limits (MCL) and background concentrations.

Since the mitigation wetlands design is based on an average water year, it is important to consider influences that higher-than-average or lower-than-average water years may have on the potential for contaminant accumulation in the wetlands. During a wet year, it is possible that the entire mitigation wetlands, including the wet meadow/shrub area, would contain surface water. If this were to occur, contaminated ground water would discharge into a much greater area of the wetlands. However, an above-average water year could cause increased dilution of contaminants if the stage of the Colorado rises sufficiently to flood into the wetlands. During such an event, any ground water gradients toward the wetlands would be reduced or reversed. During a dry year, when the water table is below ground surface throughout the entire wetland, there would be little impact on ground water flow and present contaminant migration patterns.

3.2 POTENTIAL FOR WETLANDS EVAPORATION TO CAUSE HYDRAULIC GRADIENT CHANGES

Although long-term impacts are expected to be minimal, the ground water gradient of the New Rifle alluvial aquifer may be periodically affected during times of increased evapotranspiration if the mitigation wetlands were constructed in the proposed location. These gradient fluctuations will likely increase contaminant discharge into the proposed wetland and reduce any natural flushing that is occurring at the site.

Historical surface water sampling results from locations downgradient of the New Rifle tailings show evidence of the build up of contaminants during times of increased evaporation. For example, surface samples collected from location 575 (the Roaring Fork Gravel Pit, Figure 1.1) in September of 1991, June and October of 1992, and August of 1993 showed uranium concentrations in a range from 0.36 to 0.43 mg/L. When sampled in February of 1992 and March of 1993, concentrations fell to a range from 0.03 to 0.21 mg/L. Similarly, at surface location 576, approximately 2000 ft (610 m) west of the former tailings, the uranium concentration measured 0.80 mg/L in September of 1991 and decreased to 0.17 mg/L in February 1992. It should be noted that these locations are not as close to the Colorado River as are the proposed wetlands, and thus it is less likely that they are influenced by river stage.

The relatively high average hydraulic conductivity (70 ft per day [2.5×10^{-2} centimeters per second] [DOE, 1992]) estimated for the New Rifle site alluvium should reduce the potential for significant long-term gradient fluctuations in the vicinity of the proposed wetlands and may reduce the variability of the water quality.

4.0 ECOLOGICAL CONCERNS

Water quality data from alluvial aquifer wells at and near the proposed wetland were analyzed to determine the quality of water that would feed the mitigation wetland. (Figure 1.1 shows the location of wells used in this analysis.) The analysis indicated that 20 constituents were above the background levels determined from monitor wells in the alluvial aquifer upgradient of the Old Rifle site (Table 4.1).

4.1 CONSTITUENTS WITH AQUATIC LIFE WATER QUALITY CRITERIA

State or federal aquatic life criteria were available for the following nine of the above-background constituents: arsenic, cadmium, chloride, iron, manganese, molybdenum, selenium, uranium, and zinc. The concentrations of four constituents (arsenic, molybdenum, uranium, and zinc) were below the aquatic life water quality criteria, and those constituents are not considered here. Concentrations of the remaining five constituents measured above the state and/or federal criteria and are analyzed in greater detail.

4.1.1 Arsenic, uranium, and zinc

Arsenic and uranium concentrations were below the state criteria considered protective of aquatic life and were not considered further in this analysis. Mean zinc concentrations were slightly above background levels and below the state criteria. The maximum zinc level of 1.6 milligrams per liter (mg/L) was above the state acute and chronic criteria. However, this value was from only one well; because the maximum concentrations from the other seven wells used in this analysis were well below the criteria (the range in maximum concentrations for these wells was 0.09 to 0.77 mg/L), zinc was not considered further in this analysis.

4.1.2 Molybdenum

Molybdenum concentrations were well below levels that could result in chronic effects to most biota that inhabit wetlands. A value of 0.79 mg/L can cause chronic effects to fertilized trout eggs (Table 4.1); however, the ephemeral nature of the mitigation wetlands would not support a fish population. Plants, invertebrates, and wildlife seem to be resistant to molybdenum, and the concentrations in the alluvial ground water beneath the mitigation wetlands would not be expected to result in adverse effects. If livestock such as cattle or sheep were to feed and/or drink in the mitigation wetland, adverse effects could occur. However, the proposed mitigation wetlands will be fenced to prevent livestock access. Therefore, molybdenum concentrations in the alluvial ground water beneath the mitigation site are not believed to pose a threat to vegetation, aquatic life, or terrestrial wildlife.

Table 4.1 Constituents with concentrations above background levels in the contaminated alluvial aquifer near the proposed wetland mitigation site at the New Rifle UMTRA Project site

Constituent	Maximum concentration range (mean)	Background range	Aquatic water quality criteria	
			Acute	Chronic
Arsenic	ND-0.08 (0.03)	<0.001	0.36 ^a	0.15 ^a
Ammonium	562-1750 (1071)	0.1-1.5	NA	NA
Cadmium	ND-0.13 (0.019)	<0.001	0.23 ^a	0.01 ^a
Calcium	404-514 (414)	92-230	NA	NA
Chloride	304-1750 (394)	62-260	860 ^b	230 ^b
Fluoride	2.7-6.9 (4.6)	0.4-1.2	NA	NA
Iron	0.07-18 (5.5)	0.04-2.4	NA	1.0 ^a
Manganese	7.7-13 (9.1)	0.1-4.2	NA	1.0 ^a
Molybdenum	2.3-3.7 (2.6)	0.01-0.06	NA	50 (0.79) ^c
Nitrate	<1-502 (107)	0.1-7.8	NA	NA
Phosphate	0.1-0.3 (0.16)	<0.10	NA	NA
Potassium	53-164 (64)	3.2-13	NA	NA
Selenium	ND-0.3 (0.05)	<0.013	0.135 ^a	0.017 ^a
Silica	8-27 (14)	17-25	NA	NA
Strontium	1.9-4.1 (2.3)	1.5-1.9	NA	NA
Sulfate	4260-12600 (5534)	480-1200	NA	NA
Sodium	1060-3850 (1697)	180-610	NA	NA
Uranium	0.09-0.24 (0.14)	0.001-0.046	51 ^a	32 ^a
Vanadium	0.21-2.8 (0.57)	<0.05	NA	NA
Zinc	0.09-1.6 (0.38)	<0.30	1.2 ^a	1.1 ^a

NOTE: Concentrations in milligrams per liter.

^a From CDH (1991).

^b From EPA (1991).

^c Values are current molybdenum criteria recommended by the U.S. Fish and Wildlife Service for protection of aquatic organisms except for newly fertilized rainbow trout eggs which are sensitive to molybdenum concentrations above 0.79 mg/L (Eisler, 1989).

NA = Not available

ND = None detected

4.1.3 Cadmium

Mean and maximum concentrations of cadmium were approximately 1 and 2 orders of magnitude above background concentrations, respectively (Table 4.1). In addition, these levels were above the state of Colorado chronic criterion. Elevated cadmium concentrations can result in severe deleterious effects on aquatic organisms and wildlife. Freshwater organisms are the most sensitive group; concentrations of 0.0008 to 0.0099 mg/L have been shown to be lethal to several species of aquatic insects, crustaceans, and other organisms. It has been estimated that cadmium concentrations greater than 0.003 mg/L in fresh water will be likely to result in pronounced effects on aquatic organisms and wildlife (Eisler, 1985). One reason cadmium is toxic at such low levels is its tendency to bioaccumulate; bioconcentration factors of 33 to 7440 have been calculated for freshwater insects and algae (Eisler, 1985). Because the concentrations of cadmium in the contaminated alluvial groundwater are greater than the concentrations considered safe for aquatic invertebrates and wildlife, the potential exists for cadmium to adversely affect organisms that may inhabit the proposed mitigation wetlands.

4.1.4 Chloride

The mean chloride concentration exceeds the chronic Federal Water Quality Criterion (FWQC) (230 mg/L) considered protective of aquatic life (Table 4.1). The maximum concentration is well above the acute FWQC of 860 mg/L (EPA, 1991). Data regarding the nature and severity of effects of elevated chloride on aquatic and terrestrial ecological systems are not available.

4.1.5 Iron

Mean iron concentrations in the contaminated alluvial ground water range from 2 to over 100 times background levels; the maximum concentrations are up to 450 times greater than background. The iron concentrations in the plume are also highly elevated above the state chronic criterion considered protective of aquatic life (Table 4.1). It is anticipated that iron would reach the mitigation wetlands when the ground water rises and floods part of the wetlands in the spring or early summer. Once the iron reached the surface water in the wetlands, it could precipitate out and accumulate on the bottom of the wetlands. This iron may also stimulate the growth of iron bacteria, which may form a slime on the bottom or on vegetation (SWPCB, 1952). These iron deposits and/or bacteria may inhibit the development of invertebrate populations in the wetland, thereby decreasing its usefulness to wildlife.

4.1.6 Manganese

The mean manganese concentration in the contaminated alluvial aquifer is 9.1 mg/L; this exceeds the background range of 0.1 to 4.2 mg/L and the state water quality criterion for chronic exposure of aquatic life of 1 mg/L.

Water quality conditions likely to occur at the proposed wetland mitigation site, which include neutral pH and high salinity, are conducive to a soluble and bioavailable form of

manganese (manganese oxidation state of Mn^{2+}) (Sims, 1986; Khattak and Jarrell, 1989). This indicates that when water enters the wetland, manganese would remain in solution and be bioavailable. Further, when the wetlands dry out, manganese would form a crust on the surface that would become resuspended when water returned to the area.

Another avenue for manganese to reach the mitigation wetlands is from plants rooted in the contaminated alluvial aquifer. There is evidence that under reducing soil conditions, such as those that would be provided by sediment in the mitigation wetlands, manganese could accumulate in wetland plants (Gambrell, 1994). In addition, there is some evidence that soil drying can contribute to manganese toxicity in plants. This may be related to the fact that the concentration of available manganese can increase during air drying (Graham, et al., 1988). Since manganese would be taken up by plants with roots in contaminated ground or surface water, it is likely that the manganese would return to the water and sediment when the plants decayed. It is expected that manganese would circulate through the wetlands annually. In addition, as manganese enters the wetlands each spring with the rising water table, its concentration will probably increase over time. It is likely that the cycling of manganese through the wetland will have deleterious effects on the aquatic organisms and wildlife that would occur at this site.

4.1.7 Selenium

The mean concentration of selenium in the alluvial ground water beneath the mitigation site (0.05 mg/L) exceeds the state chronic criterion, while the maximum value (0.3 mg/L) exceeds the acute criterion. Recent studies indicate selenium concentrations need to be lower than the state of Colorado criteria to be protective of the ecosystem. For example, Lemly and Smith (1987) of the U.S. Fish and Wildlife Service (FWS) recommend that selenium concentrations in water be less than 0.002 mg/L, well below the concentrations in the contaminated alluvial aquifer.

Selenium bioconcentrates as it moves up the food chain. It may result in reproductive abnormalities or failure or even death in marsh birds. For example, irrigation drainage water entering Kesterson National Wildlife Refuge in California contained an average concentration of 0.122 mg/L selenium (range of 0.0089 to 0.329 mg/L) (DuBow, 1989). Selenium concentrated in the vegetation at this refuge (algae, submergent aquatic, and emergent aquatic plants); mean selenium concentrations measured 69 to 154 milligrams per kilogram (mg/kg) selenium in plant tissue. Aquatic invertebrates contained 100 mg/kg selenium, and the only surviving fish species (mosquitofish) contained an average of 170 mg/kg selenium in its tissue (Ohlendorf, 1989).

These concentrations in the food base at Kesterson resulted in the near-complete reproductive failures of such marsh birds as the coot, grebe, stilt sandpiper, and avocet. In addition, adult mortality of these species was observed. Mammal studies indicated that voles, mice, muskrats, and raccoons contained elevated concentrations of selenium relative to a control site, but those levels had apparently not resulted in reproductive or other types of impacts to mammals at the Kesterson refuge (Clark, 1987; Clark et al., 1989).

Selenium can be expected to enter the mitigation wetlands, if they are constructed at their proposed location, when the water table rises above the bottom of the wetlands. In addition, aquatic plants rooted in the contaminated alluvial aquifer can take up selenium (Lemly and Smith, 1987); as the plants die, selenium is incorporated into the top layers of sediments and detritus. This selenium reenters the biological community through a variety of processes, including uptake by rooted aquatic plants. Selenium that enters a relatively closed system can cycle through that environment for years, even after the source of selenium in the ground water is gone. The mitigation wetlands are a relatively closed system because of minimal inflow and outflow of water; such a system could take several decades to recover from selenium contamination (Lemly and Smith, 1987).

The concentration of selenium in the alluvial ground water beneath the mitigation wetlands site is similar to that observed in the surface water at the Kesterson National Wildlife Refuge. Maximum concentrations were about 0.3 mg/L at both sites; the mean concentration at Kesterson was 0.122 mg/L and at New Rifle 0.05 mg/L. Based on this finding, the potential exists for adverse effects on wildlife, and particularly marsh birds, at the mitigation wetlands.

An influx of selenium into the wetlands will result in elevated concentrations of selenium in the invertebrates and plant life. Contamination of these food sources will pass up the food chain to birds and mammals. As indicated in Table 1.1, a variety of marsh bird species are expected to nest at the mitigation wetlands, and the levels of selenium could have an adverse effect on reproduction and survival.

In addition, nesting birds may accumulate a selenium concentration that would be harmful if the birds were eaten by humans. For example, a biological accumulation factor for selenium of 1430 has been calculated for mallards (DuBow, 1989). Multiplying this factor by the average selenium concentration in the New Rifle alluvial ground water (0.05 mg/L) results in an estimated 72 parts per million (ppm) selenium in mallard breast meat, well above the maximum recommended 1 ppm for edible portions of waterfowl (Fan et al., 1988, as cited in DuBow, 1989).

If the mitigation wetlands are constructed in their proposed location, the potential for selenium contamination is high. The potential result of such contamination is disrupted reproductive processes and/or mortality in marsh birds.

4.2 CONSTITUENTS WITHOUT AQUATIC LIFE WATER QUALITY CRITERIA

For constituents that exceed background concentrations but that do not have state or federal aquatic life water quality criteria, available toxicity data is provided here. There is no information regarding potential biological effects of the remaining constituents.

4.2.1 Ammonium

Ammonium concentrations in the alluvial ground water beneath the mitigation site are elevated, with a mean of 1071 mg/L and a maximum of 1750 mg/L. The toxic component

of ammonium is un-ionized ammonia (EPA, 1973), and the amount of un-ionized ammonia varies with pH and water temperature. Very little un-ionized ammonia is present below a pH of 7.0. The average pH of the alluvial ground water beneath the site is 7.0; at a water temperature of 16°C, the percentage of un-ionized ammonia would be 0.30. For an average ammonium concentration of 1071 mg/L, there would be 3.2 mg/L ammonia. This concentration could be toxic to fish, which have a benchmark of 1.7 mg/L, but is well below levels that may be toxic to aquatic invertebrates (daphnids) (630 mg/L) or aquatic plants (2400 mg/L) (Boyd, 1979). Therefore, since the mitigation wetlands would not support a fish population, the concentrations of ammonia in the alluvial ground water are not likely to pose an ecological threat to the mitigation wetlands.

4.2.2 Sodium

Sodium concentrations are elevated in the contaminated alluvial aquifer, with a mean of 1697 mg/L and a maximum of 3850 mg/L. The sodium absorption ratio of the contaminated alluvial ground water is 19 for the mean sodium concentration and 37 for the maximum. Water with such a high sodium absorption ratio could cause soil to become hard and impermeable if the water is applied to an upland area. The impact of high sodium concentrations on the mitigation wetlands is not known. However, results of ground water quality analysis from a well in the alluvial aquifer near an apparently healthy wetland 1500 feet to the north showed a sodium absorption ratio of 17. This indicates that the high levels of sodium in the contaminated alluvial ground water beneath the mitigation wetland site may not have an adverse effect on these wetlands.

4.2.3 Vanadium

Vanadium concentrations in the contaminated alluvial aquifer are up to 2 orders of magnitude higher than background levels. The maximum concentration of vanadium in the alluvial aquifer (2.8 mg/L) exceeds the level that is a screening benchmark for plants (0.5 mg/L) (DOE, 1994), while the mean concentration (0.57 mg/L) is just above this benchmark. Studies of aquatic organisms indicate that acute vanadium toxicity in freshwater aquatic organisms ranges from 6.4 to 30.8 mg/L (Smith et al., 1991). Because the mean concentration of vanadium is well below these toxic levels, it is assumed that vanadium would not result in toxic effects to aquatic organisms in the mitigation wetlands.

In general, the maximum vanadium concentration in the alluvial ground water is below benchmark levels that may be toxic to wildlife, while the mean concentration of vanadium in the alluvial ground water is consistently below the benchmarks (DOE, 1994). Therefore, it is assumed that the concentrations of vanadium in the alluvial ground water beneath the proposed location of the mitigation wetlands do not pose an ecological risk.

5.0 CONCLUSIONS

Construction of the Rifle UMTRA Project mitigation wetlands in the currently proposed location is not likely to significantly alter the flow of contaminated alluvial ground water from the New Rifle site. Construction of these wetlands may, however, result in adverse effects to aquatic organisms and wildlife. The proposed location is above the contaminated alluvial aquifer associated with the New Rifle site; the wetland and the plants that grow there would receive primarily water from this aquifer. Selenium concentrations in the contaminated alluvial ground water may result in adverse effects, particularly to marsh birds. Cadmium and manganese concentrations are also elevated and may result in adverse effects to biota. Other constituents, such as iron and chloride, exceed levels considered protective of aquatic life and may have an adverse impact.

The following are possible actions to meet obligations under the 404 Permit:

- Construct the mitigation wetlands at their existing location and implement a monitoring program to determine if contaminants are entering the wetlands as predicted and whether they pose a potential ecological risk. If it is determined that the wetlands pose an unacceptable ecological risk, a contingency plan that identifies potential remedial actions (such as introducing river water into the east end and discharging out the west end) should be part of the monitoring program.

As part of the monitoring program, water levels and water quality in the vicinity of the mitigation wetlands should be periodically monitored to ensure that the wetlands are not adversely affecting the natural flushing of contaminated ground water from the New Rifle site. Because the number of monitor wells located east of the New Rifle Pile area is limited and several existing monitor wells will have to be removed during wetland construction, monitor well construction locations should be incorporated into the monitoring plan.

- Construct a similar wetland elsewhere in the area of the Rifle UMTRA Project sites.
- Link wetlands mitigation to the Bottomlands Restoration Program, managed by the FWS. Under this program, the FWS has identified segments of land along the Colorado River that have been altered by human activities but that at one time provided important habitat for waterfowl and fish, such as the endangered razorback sucker. With restoration projects that typically involve earth-moving, planting, and other activities, these bottomland areas can once again provide habitat for fish and wildlife.
- Consult USACE about the possibility of locating other potential wetland mitigation sites.

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